In claim 107, line 2, change "an aqueous" to -- a heated aqueous --

In claim 112, line 3, change "an aqueous" to -- a heated aqueous --.

Please add new claims 117-121.

Claim sheets marked up to show changes are enclosed. A clean set of pending claims is also enclosed, containing all pending claims as amended and new claims 117-121.

REMARKS

Claims 98-121 are pending in the application. A Terminal Disclaimer is enclosed to overcome the double patenting rejections over U.S. Patent No. 6,240,933, and copending Application No. 09/836,080, at paragraphs 9 and 10 of the Office Action.

Translations of the Kajita JP 8-8222; Otsuka JP 03-208900; and Wada JP 62-117330 references are included. Applicant requests that the Ohmi et al. U.S. 5,487,398 patent be listed on the PTO-892. Applicant presumes that the Fukazawa reference at paragraph 6 of the Office Action means U.S. Patent No. 5,810,940 as listed on the Form 892 in paper 8. JP-160032 listed on the PTO-1449 dated 10/16/01 is also "Fukuzawa". A translation of JP-160032 is enclosed.

Reconsideration and withdrawal of the rejections is requested in view of the following remarks.

Support for new claims 118-121 is found at pages 8-11 of the specification.

All of the claims now include contacting or spraying a semiconductor article with a heated aqueous solution in combination with use of ozone, as described at pages 12-14 of the application. None of the cited references, alone or in combination, suggest contacting or spraying a semiconductor article with a heated solution while exposing the article to ozone.

With respect to the claimed heated solution and ozone elements, all the prior art cited falls into either the immersion tank processing category or the spin processing category. In the immersion category are: Matthews '480; Otsuka JP H03-208900; Wada JP 62-117330; Fukazawa et al. '940 and Schellenberger et al. '203.

Matthews '480 teaches placing wafers into a process tank containing subambient deionized water for removing organic materials from the wafer (col. 5, lines 17-24; col. 6, lines 35-37). Otsuka et al. and Wada et al. teach bubbling an oxidative gas onto a wafer immersed in a liquid bath. Fukazawa et al. teaches placing a wafer into a cleaning vessel that is filled with overflowing deionized water (abstract; col. 2, lines 42-45). Schellenberger et al. teaches dipping a substrate into a liquid bath (Abstract; col. 2, lines 34-37).

Among these immersion references: Matthews teaches away from heating (1-15° C at Col. 3, line 63); Fukazawa and Schellenberger et al. are silent on temperature (although Schellenberger et al. which concerns only drying wafers, claims ranges of 0-100° and 20-50°, without explanation, at Col. 6); Otsuka describes immersion in a solution having a maximum temperature of 80°C, optionally including ozone gas bubbles (Translation p. 9); and Wada et al. describes a cleaning liquid bath at up to 140° C, with ozone bubbling up to an immersed wafer.

Hence, among these immersion prior art references (which may also disclose use of ozone, dissolved, or bubbled into the immersion bath) the suggestion to use heat, or to not use heat, is ambiguous at best. Clearly these references do not reasonably suggest use of heated liquid and ozone in a non-immersion liquid application or spray as claimed. None of these immersion-type of references suggest rotating the workpiece, as in claims 98, 117 or 118. These references also do not suggest spraying, as in claims 101, 107 and 112 because they only use immersion.

As explained at pages 1-4 of the application, the liquid bath cleaning techniques currently used in the semiconductor manufacturing industry require a relatively large number of steps, using a relatively large number of chemicals. As a result, they are time-consuming and they slow the manufacturing process. Additionally, the equipment required to perform these liquid bath techniques is bulky, as various tanks are needed, and the fabrication facility must therefore provide space for the tanks. This adds to the overall processing costs. Moreover, the spent chemicals from such facilities must be appropriately disposed of in an environmentally acceptable way, further increasing the costs for cleaning semiconductor articles. It does not appear that any of the immersion prior art references discussed above have overcome these disadvantages.

The prior art in the non-immersion and/or spin processing category are Ohmi '398; Matsuoka EP 596; Lampert et al. '985; and Kajita JP 8-8222.

Ohmi and Kajita are silent on temperatures.

Lampert describes forming a mist using water at 10-90° C (Col. 7, line 11) and then forming liquid phase chemicals by reacting gas phase chemicals with the water mist. The mist is not an aqueous solution as claimed. Rather, it is a low volume aerosol having inadequate heat capacity needed for heating the workpieces. The mist of pure water interacts with a gas to form a chemically active substance, which removes contaminating particles from the wafer (col. 2, lines 52-55; col. 4, lines 59-64). In Lampert et al., the use of a mist, or finely divided water, is apparently essential, to allow the gas to react with the water (col. 2, lines 52-55). The use of such a mist or fog makes effective processing difficult or impossible to achieve because the mist cannot be made uniform throughout the chamber (see, e.g., Ohmi et al., Col. 4, lines 60-63).

Lampert, in essence, is a form of the 4-Chem or RCA clean described at pages 1-3 of the specification, but using gases for chemical generation, instead of liquids.

Matsuoka (EP 548596) teaches away from heating: "Heating the substrates does not permit wet ozone to have well-enough effects, because any thin water film cannot occur even when a wet ozone-containing gas is fed." Page 3, lines 32-35. In example 1 of EP 596, the water temperature is 25° C. Page 5, line 55. In comparative Example 1, the water is at 20° C. Page 6, line 12. Consequently, Matsuoka EP 596 suggests use of liquid only at room temperature.

Claims 98 describes rotating an article or a wafer, and contacting a heated aqueous solution and ozone onto the wafer, and rinsing. None of the immersion prior art suggests rotating. None of the non-immersion and/or spin processing prior art suggests use of a <u>heated aqueous solution</u>. Claim 98 is therefore patentable.

Claims 107, 112 and 117 describe rotating a wafer, spraying a heated aqueous solution, contacting with ozone and rinsing. None of the immersion prior art suggests rotating or spraying. None of the non-immersion and/or spin processing prior art suggests use of a heated aqueous solution. Claims 107, 112 and 117 are therefore patentable.

New claim 118 describes rotating the article in a gas environment, applying a heated aqueous solution, contacting with ozone, and rinsing. None of the immersion prior art suggests rotating or a gas environment. None of the non-immersion and/or spin processing prior art suggests use of a heated aqueous solution. New claim 118 is therefore patentable.

In view of the foregoing, it is submitted that the claims are in condition for allowance, and a Notice of Allowance is requested.

Respectfully submitted,

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Claim Sheet Marked Up To Show Changes

98. (Amended) A method for cleaning semiconductor wafers comprising:

(a) rotating a wafer in a processing chamber;

(b) contacting a surface of the wafer with [an aqueous] a heated aqueous solution and simultaneously contacting the wafer with ozone in an amount sufficient to create an oxidizing effect on the surface of the wafer to oxidize contaminants thereon; and

(c) rinsing the surface of the wafer to remove oxidized contaminants from the surface thereof.

107. (Amended) A method for cleaning semiconductor wafers comprising:

(a) spraying onto a rotating wafer [an aqueous] a heated aqueous solution while simultaneously contacting the wafer with ozone to effect oxidation on the surface of the wafer; and

(b) rinsing the surface of the wafer.

112. (Amended) A method for cleaning semiconductor wafers to remove organic materials from the surface there of comprising:

(a) spraying onto the surface of a rotating wafer [an aqueous] a heated aqueous solution and simultaneously contacting the wafer surface with ozone to effect oxidation of the organic materials on the surface of the wafer to oxidize said contaminants; and

(b) removing from the surface of the wafer oxidized contaminants.